

Part I

REPORTS, REVIEW, AND PUBLICATIONS

REPORT OF THE CALCOFI COMMITTEE 2011

CDFG HIGHLIGHTS

Marine Regulatory Changes

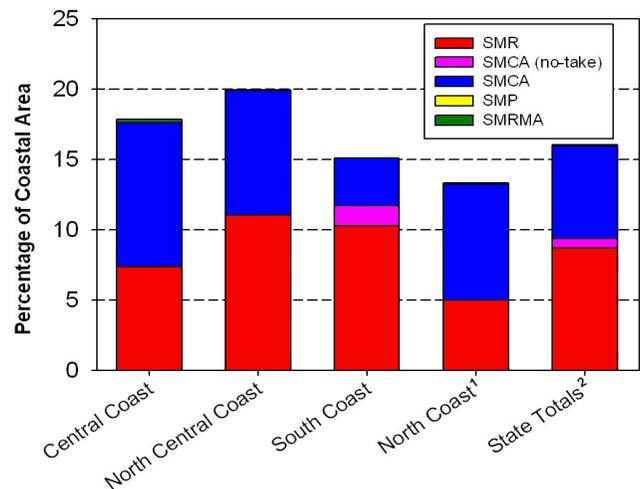
In 2011, the California Fish and Game Commission undertook 14 rule-making actions that addressed marine and anadromous species. The Commission adopted changes to commercial or sport fishing regulations that include ocean and inland salmon, herring, greenling, abalone, and Kellet's whelk.

Marine Life Protection Act

The Marine Life Protection Act (MLPA) mandates the re-examination and redesign of a network of Marine Protected Areas (MPAs) for California. The MLPA is being implemented in five planning regions encompassing the entire California coastline, including San Francisco Bay. In 2011, the goal for a statewide network of MPAs is nearing completion with the implementation of 29 MPAs in the central coast, 25 MPAs and seven special closures in the north central coast, and 50 MPAs (including those previously adopted in the northern Channel Islands) and two special closures in the south coast. Adoption for the 20 proposed MPAs and seven special closures in the north coast is expected summer 2012. Implementation of north coast MPAs and special closures will result in an improved statewide network comprised of 124 MPAs and 16 special closures covering approximately 848 square miles or 16% of state ocean waters. With regard to longer term management, in March 2011 CDFG convened the "Marine Protected Areas and Fisheries Integration Workshop" to elicit input from a broad range of scientists on fisheries management and MPAs. The CDFG continues to play a role in the long term monitoring efforts of MPAs through close affiliation with the California MPA Monitoring Enterprise and by pursuing a CDFG based subtidal monitoring program using scuba and ROV, as well as database management.

Ocean Protection Council

The Ocean Protection Council (OPC) approved a \$990,000 grant to the nonprofit California Wildlife



¹ Based on MPAs in the north coast preferred alternative, and may be subject to change depending on the final north coast MPAs that are adopted.

² State totals include all MPAs in effect in the central coast, north central coast, and south coast regions and MPAs in the north coast preferred alternative under Commission consideration; they do not include existing MPAs in San Francisco Bay or special closures. Special closures were integrated into the MPA designation process and were used to provide further protections that would not otherwise be afforded by MPA designation within the same geographical location.

Foundation to support the Department's development of a spiny lobster Fishery Management Plan. The OPC is also working closely with California Sea Grant and CDFG to fund MLPA and baseline monitoring of the new network of MPAs in state waters.

Coastal Pelagic Species

The market squid fishery had another banner year in which the harvest guideline was reached for the second year in a row. Staff participated in monitoring and tracking fishery landings to ensure a timely closure in response to the guidelines. Staff attended the second Sardine Otolith Workshop which resulted in plans to formalize the organization to further methods in CPS otolith research. CPS staff assisted with the Pacific mackerel stock assessment, where California Recreational Fishery Survey data was used for the first time as a fishery dependent index of abundance.

Aquaculture and Bay Management

The Aquaculture and Bay Management Project completed its annual monitoring and assessment activities for the San Francisco Bay commercial Pacific herring fishery for the 2011–12 season. The spawning biomass estimate for the 2011–12 season is 60,987 tons, well above the historical average (1978–79 season to the present) of 49,670 tons. Though the herring population has increased significantly since the historic 2008–09 season population low of 4,844 tons, the Department remains concerned about the low percentage of five- and six-year-old herring in the spawning population. Due to the ongoing age structure concerns, the Department will continue to recommend precautionary management principles for safeguarding the spawning population. As a result, for the 2012–13 season, the Department is recommending that the Fish and Game Commission adopt a conservative harvest rate of 5% of the 2011–12 spawning biomass. This would allow for a quota of 2,854 tons.

Invertebrate Fisheries Management

The Dungeness crab trap limit program was implemented in 2011 with the passage of SB 369. The Department was tasked with developing a set of rules to implement this tiered trap allocation system for the 2013 crab season. There will be seven tiers with the highest tier allocation set at 500 traps and a system of colored and numbered buoy tags used to identify vessels and their tier.

The Department and the FG Commission worked together to proactively manage the emerging Kelleys whelk fishery. New regulations were approved in 2011 that will set a total allowable catch and a closed season in the spring to protect spawning and egg-laying aggregations.

The stock assessment element of the spiny lobster fishery management plan was completed in 2011. The Department's Doug Neilson collaborated with Mexican fishery biologists in adapting their size-structured Fishery Simulation Model (FISMO), based on von Bertalanffy growth and Beverton-Holt recruitment, for southern California. In the model, the lobster stock was sustainable at present sport and commercial fishing levels.

An unprecedented die-off of marine invertebrates occurred coincident with a harmful algae bloom (aka red tide) along the Sonoma County coast in August, 2011. Significant numbers of red abalone, sea urchins and other invertebrate species were affected. At Fort Ross, red abalone populations are estimated to have been reduced by 30 percent, while at other Sonoma Co. sites such as Salt Point, mortality estimates ranged from 12 to 25 percent. The majority of dead abalone were found in depths

<10m. The FG Commission issued an emergency closure of the red abalone fishery in Sonoma County closing the remainder of 2011 season.

Ocean Salmon

Ocean salmon fishing regulations were adopted that allowed for a fishing season, and inland salmon season regulations were adopted for the Central Valley, and Klamath and Trinity Rivers. This represents the first restoration of the traditional salmon fishery throughout California since major closures were enacted in 2008 and 2009 (for both ocean and inland waters) in which virtually no fishing was allowed because of low abundance forecasts and poor returns of fish to the Sacramento River Basin.

Groundfish

In 2011, the Groundfish Project prepared environmental documents for the 2013–14 federal biennial groundfish regulations for the Pacific Fishery Management Council including developing and analyzing regulatory options. California's representative on the Council's Scientific and Statistical Committee focused on Council-related discussions and reviews, including but not limited to: stock assessments, harvest specifications, essential fish habitat, and exempted fishing permits. At the state level, staff prepared regulation changes for greenlings, which went into effect in 2012, to provide increased harvest limits based on new information and increased federal limits. Lastly, staff prepared a manuscript submitted to Fish Bulletin that documents all of California's commercial historical landings from 1987–99. This paper completes the published information on commercial landings in California from 1916 to 2010.

The statewide total allowable catch for kelp greenling was increased from 37,600 pounds to 121,900 pounds with up to 55,400 pounds allowed for the commercial fishery and up to 66,500 pounds allowed to be taken recreationally. In the recreational fishery, the Greenling limit increased from two to ten fish.

California Recreational Fisheries Survey

The California Recreational Fisheries Survey (CRFS) and the Recreational Fisheries Data Project worked to transition California's saltwater sport angler intercept surveys to a California Department of Fish and Game program. In 2011 the projects jointly developed data entry and estimation programs for the commercial passenger fishing vessel (CPFV) mode of fishing, entered data that was collected dockside and onboard CPFVs, and produced estimates of total catch and effort. An independent review of CRFS sampling methods and estimation procedures was conducted by consultants hired by NOAA Fisheries' Marine Recreational Information Program.

The consultants concluded it is “a well-designed and executed program” and provided recommendations for improvements.

California Finfish Research and Management Project

The first statewide stock assessment for California halibut was completed by Dr. Maunder in 2011. Project staff provided data sets and worked with Dr. Maunder throughout the process and peer review. The stock assessment, Peer Review Panel Report and History of Fishery Regulations, were placed on the project web site in August 2011 (<http://www.dfg.ca.gov/marine/sfmp/halibut-assessment.asp>). The status of the halibut biomass north of Point Conception was relatively high with several recent recruitment events. Favorable environmental conditions appear to be driving recruitment and fishing was not considered to be a significant negative factor impacting biomass. South of Pt. Conception, the halibut population was estimated to be depleted at 14% of historic levels. The population was considered depleted at the start of the assessment period (1980) due to historic exploitation. Staff communicated the results of the stock assessment to the FG Commission as well as conducted three public workshops in southern California.

Preliminary results from a three year surf fish study consisting of 364 beach seine hauls at four southern California beaches indicate barred surfperch abundance has greatly declined since the 1950s, while leopard shark abundance has increased. Staff completed a report on barred sand bass spawning habitat characteristics at Huntington Flats during peak spawning season. It appears strong tidal fluxes and the development, persistence, and temperature of the thermocline may directly influence spawning aggregation formation. For more information see <http://www.dfg.ca.gov/marine/scuba/index.asp>.

SIO HIGHLIGHTS

This past year saw the Scripps CalCOFI program transition to NOAA funding through the new Cooperative Institute for Marine Ecosystems and Climate (CIMEC). Although this transition entailed a significant increase in the overhead rate charged for non-ship and equipment items, NOAA funding maintained the program at its current level of services, despite the difficult fiscal climate. The CalCOFI Committee views this as a strong endorsement of the program’s value to the ocean science and management community.

Four CalCOFI cruises were carried out successfully over the last 12 months. A comprehensive range of ancillary measurements are now made on the cruises, funded by the California Current Ecosystem Long-Term Ecological Research Program (CCE LTER), the Southern California Coastal Ocean Observing Pro-

gram (SCCOOS), the U.S. Navy, and private sources: enhanced coastal station coverage; the carbon cycle, including underway pCO₂, alkalinity, CO₂ and pH; particulate and dissolved carbon and nitrogen; bio-optical properties; phytoplankton community structure from HPLC, microscopy, and Advanced Laser Fluorescence (ALF); bacteria and picoautotrophs from flow cytometry; nano- and microheterotrophs from microscopy; mesozooplankton species groups and size composition from microscopy and Zooscan image analysis; micronekton from multifrequency acoustics and pelagic trawling; seabirds from visual observations; and marine mammals from passive acoustics and visual observations. These measurements, in addition to standard CalCOFI measurements of temperature, salinity, oxygen, nutrients, and chlorophyll with CTD and bottle measurement, primary production, zooplankton and ichthyoplankton, enables CalCOFI cruises to monitor physical processes, biogeochemical cycles and major ecological groups within the southern California Current. The CalCOFI Committee is committed to making these data sets available to marine research and management communities, in particular to nascent efforts to develop ecosystem-based management of the California Current.

NOAA HIGHLIGHTS

CalCOFI Ichthyoplankton Update

During the past year the SWFSC Ichthyoplankton Ecology laboratory continued to retroactively update identifications of fish eggs and larvae to current standards from 1951 to the present. Identification of Pacific whiting (hake) and jack and Pacific mackerel eggs collected in the oblique net samples are now complete from 1984 to the present, and identifications of all larvae have been updated from 1966 to the present.

We have identified market squid paralarvae from CalCOFI bongo samples since 1997 and from neuston samples dating back to 1981. All cephalopod paralarvae have been identified since 2008. The presence or absence of jumbo squid paralarvae has been of interest in recent years; no ommastrephid paralarvae were collected in 2011, and none has been since the summer of 2008.

We collaborated with Ron Burton and his students at SIO on the development of a high-throughput system for molecular identification of ichthyoplankton. The ultimate aim of this project is to provide accurate, near real-time identifications of fish eggs, which often are difficult or impossible to identify to species using traditional morphological characters. When fully developed, this method will enable us to accurately identify the spawning locations of several taxa that are valuable to sport or commercial fisheries such as Pacific hake, Pacific mackerel, white seabass and California barracuda. These

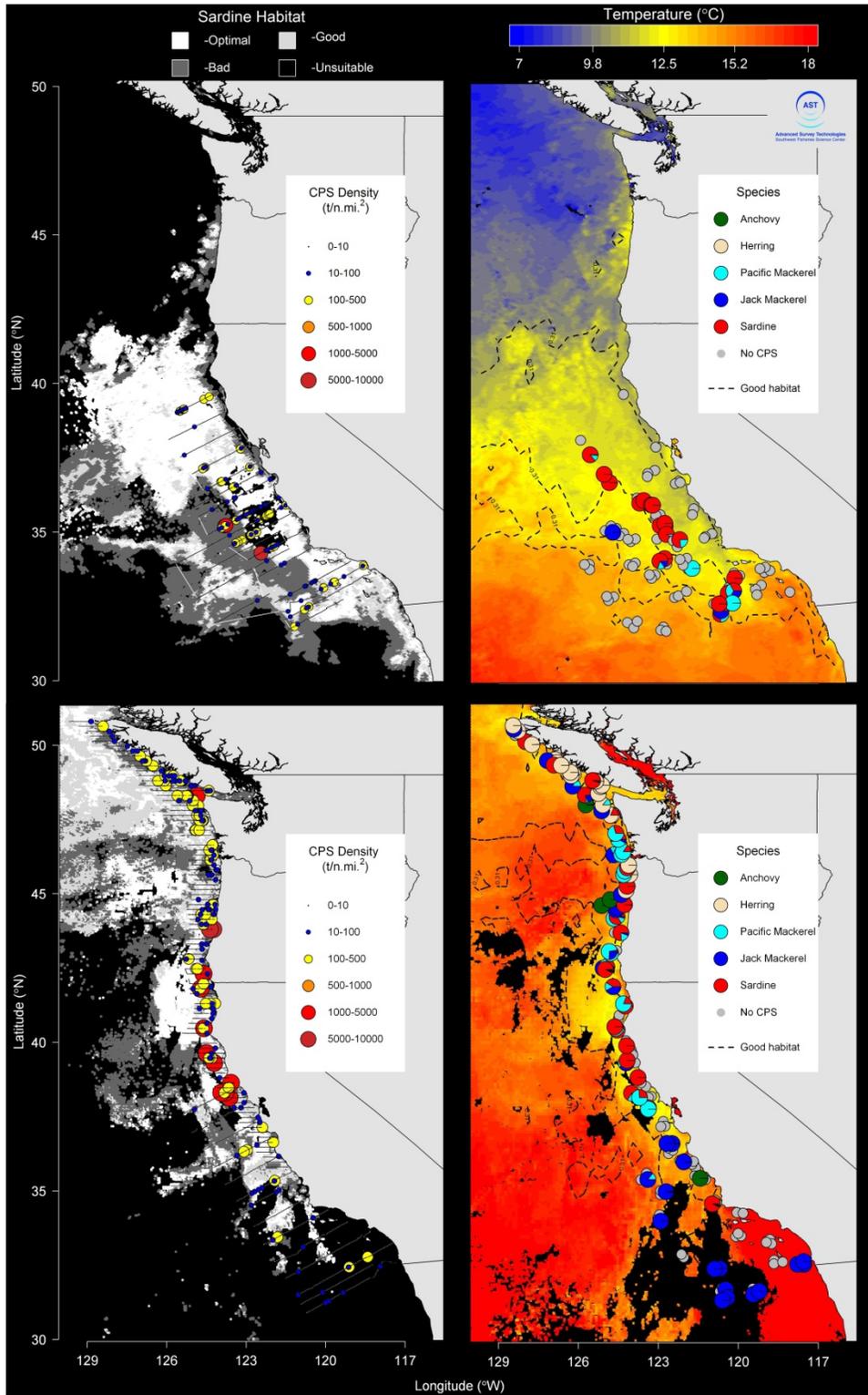


Figure 1. Mass densities of coastal pelagic fish species (CPS; left); and proportions of CPS in trawl catches (right) from the spring (top) and summer (bottom) Acoustic-Trawl-Method (ATM) surveys.

techniques will be applied to ethanol-preserved CalCOFI samples to develop a time series for eggs from 1997 to the present. During the past year we completed sorting eggs and larvae from ethanol-preserved samples from winter cruises in 2002, 2003, and 2005. We analyzed the larval fish assemblage from the winter CalCOFI cruises in 2002–04, which coincided with detailed sampling within the Cowcod Conservation Area (CCA), a marine reserve embedded within the core CalCOFI sample frame. We evaluated assemblage dynamics from both the relatively large (CalCOFI) and small (CCA) spatial scales and found that the larval fish assemblage changed significantly during a transition from La Niña (2002) to El Niño conditions (2003–04) at the smaller scale, but was relatively stable through time at the larger scale. A manuscript describing these results was published PLoS ONE (7:e33131).

We also collaborated with Nathalie Reyns and a graduate student from USD to evaluate dynamics of bocaccio larvae using samples from the 2002–04 CalCOFI and CCA cruises. Results of this work were published in Marine Ecology Progress Series (465:227–242).

To enhance understanding of how ichthyoplankton respond to environmental variability throughout the California Current system, we are analyzing CalCOFI data together with ichthyoplankton and environmental data collected between 1997 and the present in Oregon by Oregon State University and the NWFSC, and from Baja California by CICIMAR. In collaboration with Toby Auth and Ric Brodeur from Oregon, and Martin Hernandez-Rivas and coworkers from Mexico, we are preparing a manuscript describing these results and will give a talk on them at the 2012 CalCOFI meeting.

Spring and Summer Coastal Pelagic Species cruises

In Spring 2012 another coast-wide survey was conducted using two vessels (*Bell Shimada* and *Ocean Starr*), combining the CalCOFI with Coastal Pelagic Species (CPS) cruise. The spring CalCOFI was conducted aboard the *Bell Shimada*. The spring CalCOFI was plagued by poor weather this year, at times causing *Shimada* to take shelter when significant wave heights reached 4–5 m. Sampling on line 80 was badly affected by heavy weather, as evidenced by the zigzag cruise track. The cruise also started badly for *Ocean Starr* which was stuck in Seattle due to atrocious weather off Washington for almost 5 days. Due to the extensive delay, the *Ocean Starr* begin survey from Cape Mendocino rather than Cape Flattery. Data were collected on lines 50, 53, and 57 between Cape Mendocino and San Francisco, but the weather meant that most of leg one was used in transiting from Seattle to San Francisco. A few sardine were collected in trawls packed with heavy loads of

gelatinous zooplankton, but the sardine were not reproductively active.

Four surface drifters were deployed from the *Ocean Starr* at station 93.53 in collaboration with Luca Centurioni's lab at SIO to track currents advecting eggs and larvae. Drifter data will be compared to modeled egg and larval drift derived from GCM and ROMS models outputs from SIO (Bruce Cornuelle and Art Miller's groups).

The second leg of the spring coast-wide ecosystem survey on *Shimada* sailed from San Diego on April 12. Due to low abundance of sardine eggs in the area offshore from the Southern California Bight, the survey lines were adjusted to focus on the central California coast. Egg counts from CUFES obtained anywhere this year are low. The trawl net, including the marine mammal excluder (MMED), was lost due to unknown causes on April 18. A replacement MMED for the spare trawl net was constructed aboard *Shimada* to avoid loss of survey time.

The second leg of the survey on *Ocean Starr* sailed from San Francisco on April 7 following repairs to the marine mammal excluder device and adjustment of the position of the trawl net roller. Trawls could then be retrieved more efficiently despite heavy catches of gelatinous zooplankton. The CTD unit on *Ocean Starr* malfunctioned but a replacement unit was obtained for leg three from the SWFSC Antarctic Division.

The spring coastwide ecosystem survey on *Shimada* ended on April 30 and on *Ocean Starr* ended on April 29. Both vessels returned to port in San Francisco. The final weekend brought more rough weather and some damage to the trawl on *Shimada*. Objectives of the survey in the region to the south of Cape Mendocino were generally achieved, despite a bad start due to mechanical problems experienced on *Shimada*, followed by poor weather that affected both vessels. As in 2010 and 2011, the sampling between Cape Mendocino and Cape Flattery did not meet planned objectives.

An even more extensive coastwide survey was conducted from these two vessels in summer 2012. *Ocean Starr* leg one (CalCOFI) sailed on July 2 with 4 SWFSC staff aboard (Dave Griffith, Amy Hays, Bryan Overcash, and Josiah Renfree). The cruise suffered delay due to cable problems on the CTD winch. The SIO CTD/rosette was recovered intact from deployment, with some difficulty. This occurred at the very beginning of the cruise causing the vessel to return from an inshore station on Tuesday evening and to moor in San Diego Bay. Repairs were completed and the summer CalCOFI leg sailed again on July 9, delayed by a week. *Ocean Starr* leg one (CalCOFI) ended in San Diego on Friday July 27 and the Coastal Pelagic Species part of the cruise sailed from San Diego on Monday July 30. The second gen-

erator required to operate winches failed on August 2, necessitating another return to San Diego for 24 hours. *Ocean Starr* legs two and three (CPS) then continued without incident. There were few fish eggs collected by CUFES, but occasionally there were modest numbers of jack mackerel, sanddabs, *Vinciguerria*, and possibly Dover sole. CUFES counts were dominated by pelagic squid eggs. Trawl catches were dominated by market squid of a variety of sizes, and an occasional catch of jack mackerel.

Ocean Starr arrived at Port Hueneme early on Wednesday August 29. Sam McClatchie and 11 SIO technicians, scientists, and students from Uwe Send's lab spent the next three days maintaining and redeploying subsurface moorings prior to returning to Port Hueneme for the start of the Island wake study. Despite quite rough weather, work proceeded to plan. The SIO group of Uwe Send has developed a new method for obtaining near-real-time data from subsurface moorings by using a spray glider to download the data from the mooring using an underwater acoustic link, and then rising to the surface to transmit the data from the glider via satellite to shore. The glider loiters at 500 m depth in between it's daily data delivery ascents, thereby saving batteries and permitting the glider to be on duty at the mooring for a full year.

Ocean Starr leg four (Island wake study) began on Sunday, September 2 after disembarking 11 SIO mooring staff from Uwe Send's group following the 3-day mooring cruise. The goal of the Island wake study was to determine if juvenile fishes were associated with productivity hot spots around the Channel Islands. The cruise was a successful multidisciplinary collaboration between SWFSC (fisheries oceanography, ship operations, ichthyoplankton, and Advanced Survey Technology) and SIO (Marine Physical Lab, mooring group, drifter group, and marine mammal acoustics). Preliminary results revealed no juvenile fish hot spots. Instead we encountered a flatfish larva hot spot between Santa Cruz and Santa Rosa Island, and a remarkable concentration of blue, fin and humpback whales feeding to the west of Santa Rosa Island. The zooplankton were dominated by several species of salps. The glider resolved internal waves in the area to the west of the islands, and drifters showed eddying at several spatial scales in the wake from the Channel Islands.

The 2012 field season has been an extraordinary effort by the SWFSC ship operations team. Amy Hays spent 134 days at sea, Sue Manion spent 131 days, and Dave Griffith spent 121 days at sea.

Spring and Summer Acoustic-Trawl-Method Surveys

During both the spring and summer, the SWFSC conducted Acoustic-Trawl-Method (ATM) surveys for

coastal pelagic fish species (CPS), e.g., sardine, jack and Pacific mackerel, anchovy, and herring. Sampling during spring was focused on the spawning aggregation of sardine, offshore between San Diego and San Francisco, California (CA); sampling during summer was focused nearshore between central CA and Vancouver Island (VI), Canada.

The ATM uses ship-based, multiple-frequency echosounders to map the distributions of CPS; and trawl catches to apportion the echo energy to species and convert those values to animal densities. During daylight, from sunrise to sunset, multifrequency echosounders (38, 70, 120, and 200 kHz) were used to sample acoustic backscatter from CPS. During nighttime, surface trawls were used to identify the proportions of CPS and their lengths. The data were combined to estimate density-weighted fish-length distributions. This procedure resulted in maps of fish densities and estimates of their biomasses, by species and lengths (presented elsewhere).

The spring ATM survey was conducted from NOAA FSV *Bell M. Shimada* and chartered FV *Ocean Starr*. The ATM survey totaled 2,248 nmi of trackline spanning over 51,327 nmi² and the distribution of the northern stock of sardine predicted by a model of potential sardine habitat (fig. 1, top left). Sardine catches spanned the latitudinal extent of the survey, but were not found in the coastal region and the far offshore oceanic transects (fig. 1, top right).

The summer ATM survey was conducted from NOAA FSV *Bell M. Shimada* and chartered FV *Ocean Starr* off the west coasts of the USA and Vancouver Island, Canada: Leg I: 24 June–6 July; Leg II: 9–25 July; Leg III: 30 July–12 August; and Leg IV: 15–24 August. The ATM survey totaled 3,632 nmi of trackline spanning over 39,614 nmi² and the expected distribution of the northern stock of sardine (fig. 1, bottom left). Transects were spaced 10 nmi, generally, extending from 40 to 1500 m depths, to at least 35 nmi offshore.

During the summer ATM survey, the habitat in the Southern California Bight was unsuitable for the northern stock of sardine, and was bad during August off the west coast of VI (fig. 1, bottom left). CPS densities were low south of Monterey, higher from central CA to central Oregon (OR); and relatively uniform and low off Washington (WA) and VI. The region off northern CA and southern OR contained the largest concentration of CPS backscatter (fig. 1, bottom left). Jack mackerel were mostly offshore of southern and central CA; sardine were mostly between San Francisco and central OR; anchovy were patchy off central CA, central OR, and near the Strait of Juan de Fuca; and herring were offshore of WA and VI (fig. 1, bottom right).

Shark Surveys

The SWFSC's shark research group is responsible for collecting data to support the management of blue (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), and common thresher sharks (*Alopias vulpinus*), all of which are common in off the U.S. West Coast and taken in regional fisheries, primarily as juveniles. Common thresher and mako sharks have the greatest commercial value and are also targeted by sport fishers. Although the blue shark has little market importance in the United States, it is a leading bycatch species in a number of U.S. fisheries and is targeted in Mexico. One of the primary methods used by NOAA Fisheries to collect data on the three species is fisheries independent surveys. These surveys provide catch data that allow us to track trends in abundance. Use of fisheries data alone for estimating population status is complicated by changes in regulations, fishing methods, and areas over time. The surveys also provide the opportunity to deploy conventional and electronic tags, obtain biological samples and conduct studies on age and growth.

In June and July 2012, the SWFSC conducted its annual juvenile mako and blue shark abundance survey in the Southern California Bight. Working aboard FV *Ventura II*, the team of scientists and volunteers fished a total of twenty-eight survey sets with 5,592 hooks. Survey catch totaled 115 shortfin mako sharks, 26 blue sharks, 16 pelagic rays (*Pteroplatytrygon violacea*), and 4 opah (*Lampris guttatus*). The preliminary data indicate that the nominal survey catch rate was 0.535 per 100 hook-hours for shortfin mako and 0.150 per 100 hook-hours for blue sharks. The mako shark nominal CPUE was slightly higher than the previous year. However, there is a declining trend in nominal CPUE for both species over the time series of the survey.

Twenty eight additional longline sets and several hours of trolling each day were also conducted in areas beyond the survey sampling blocks for other highly migratory species life history studies. A total of 423 animals were caught during survey and ancillary sampling throughout the course of the cruise. Most animals were brought onboard and measured, tagged, and a DNA sample was

collected before they were released. Spaghetti tags were released on 338 sharks for movement and stock structure data. A total of 387 DNA samples were collected, including samples from 254 shortfin mako, 92 blue shark, 29 opah, 9 pelagic rays and 3 common thresher. Opah is one species that has been caught in relatively high numbers in recent years. Fourteen opah were caught in 2011, sixteen in 2010, and eight in 2009. Prior to 2009, only one other opah had been recorded during a longline survey cruise. As opah are also one of the more commonly taken species in the swordfish drift gillnet fishery in recent years, the SWFSC has initiated a number of biological studies on opah including popoff tagging and respiratory physiology studies.

In September 2012, the SWFSC conducted its annual thresher shark nursery area survey in the Southern California Bight. Fifty nearshore longline sets were conducted aboard the FV *Outer Banks* over 18 days between Point Conception and the US/Mexico border. This survey continues an annual time-series started in 2006 tracking the relative abundance of thresher shark pups and juveniles (ages 0–2) in waters of less than 25 fm. The nominal catch rate for threshers was slightly down from 2011, the year with the highest catch rate for the time series so far. Nevertheless, over 260 threshers were caught tagged and released for movement and stock structure data, DNA samples were collected for genetic population studies, blood was collected from several animals for a collaborative study with NWFS examining domoic acid levels, and a towed GPS positioning tag was released on a healthy threshers to examine detailed movement and migration patterns. Morphometric information and biological samples were collected from the few non-surviving animals in support of ongoing life history and feeding habits studies. Pacific mackerel were also collected for an ongoing reproductive maturity study.

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